THE OHIO HERPETOLOGICAL SOCIETY

Special Publication Number 3 — 10 February 1961

Notes on the Life History of *Agama agama africana* (Hallowell) in Liberia

Paul M. Daniel

Department of Physiology
Miami University
Oxford, Ohio

Special Publication of The Ohio Herpetological Society
Number 3, Pages 1- 5, Tables 1-2

Published by the Society
2370 Club Road
Columbus 21, Ohio

THE OHIO HERPETOLOGICAL SOCIETY

Board of Directors

Kraig K. Adler, Chairman
2370 Club Road, Columbus 21, Ohio

David M. Dennis, Vice-Chairman for Publications
2063 Ormond Avenue, Columbus 24, Ohio

Paul M. Daniel, Vice-Chairman for Membership
Department of Physiology, Miami University
Oxford, Ohio

Lindsay W. Wood, Treasurer
2892 Plymouth Road, Cleveland 24, Ohio

Alan C. Witten, Secretary
1020 Fairfield Drive, Van Wert, Ohio

Dr. George T. McDuffie, Member-at-Large
Department of Zoology, University of Cincinnati
Cincinnati, Ohio

EDITORS FOR THIS NUMBER

Dr. Robert C. Stebbins, University of California, Berkeley
Arthur Loveridge, Island of St. Helena, South Atlantic Ocean
Kraig K. Adler, Columbus, Ohio

SOCIETY PUBLICATIONS. The Special Publications are designed to present lengthy papers on herpetology, whereas the Journal contains shorter papers and notes. Both are edited by Kraig K. Adler. The dittoed Newsletter, edited by Vinnie Lawrence, contains items of interest to members.

MEMBERSHIP. Membership applications may be obtained from Prof. Paul M. Daniel, Vice-chairman for Membership, Department of Physiology, Miami University, Oxford, Ohio. Membership includes subscription to all publications and is open to all. Annual dues for 1961 are: Individuals, U.S. & Canada, $1.00; Foreign, $1.50; Institution, $1.75.

BACK-ISSUES AND LIBRARY. A list of available back-issues and other publications available from the Society may be had by writing the Librarian, William A. Kuhns, Jr., 1509 Westdale, South Euclid 21, Ohio. The Society has a modest library on Ohio herpetology; papers and books may be loaned to members providing the Society is reimbursed for postage. Address inquiries to the Librarian.

MANUSCRIPTS. Manuscripts must be typewritten, follow those instructions given in Copeia 1958 (1): 67-69, and should be addressed to the Editor, 2370 Club Road, Columbus 21, Ohio. Reprints supplied at cost; send order with manuscript.

NOTES ON THE LIFE-HISTORY OF AGAMA AGAMA AFRICANA (HALLOWELL) IN LIBERIA*

by Paul M. Daniel

Introduction: A study of the life-history of Agama agama africana was made while the writer was teaching at Cuttington College, Suacoco, Liberia, West Africa. All lizards included in the study were obtained in the vicinity of the college campus during the period June 1950 to November 1953.

Description: The agamid lizards comprise an Old World family bearing many resemblances to the New World Iguanidae. A family characteristic is the presence of heterodont teeth with some usually resembling molars, canines, and incisors. The Splenoid bone is reduced or absent but is well developed in the iguanids. Boulenger (1885) presents a complete description of the family and states that division into genera is difficult. The genus Agama is distinguished by a distinct tympanum, more or less depressed body, rounded or feebly compressed tail, no femoral pores, but males with callose preanal scales. Members of the genus are found in Southern Asia, Southeastern Europe and most of Africa (Boulenger, 1885).

Loveridge (1936) demonstrates at least four races of Agama agama. He justifies these distinctions on the basis of mid-body scale rows. He indicates that a given race usually varies only by about ten mid-body scale rows, rarely as many as thirteen. The literature indicates that the race under consideration has from fifty-eight to sixty-eight, while the typical form has from sixty-two to possibly eighty-four, by inclusion of subsequently separated forms. Loveridge demonstrates a definite decrease from east to west in mid-body scale rows. The typical form is found in Eastern Uganda and the Congo, west to Nigeria and possibly Ghana. The western race, africana, has been recorded in Liberia and Senegal and undoubtedly is found in Sierra Leone and the western regions of Guinea.

The synonomy follows:

Agama agama africana (Hallowell).

1844 Tropidolepis Africanus Hallowell, Proc. Acad. Nat. Sci. Philadelphia, 1844, p. 171 (Liberia).
1845 Calotes versicolor Hallowell (not of Daudin), Proc. Acad. Nat. Sci. Philadelphia, 1845, p. 247 (Liberia).
1884 Agama savatieri Rochebrune, Faune de la Senegambia, Rept., p. 89, pl. 11, figs. 1-2 (Bathurst, Gambia [Restricted]).

Ten male and ten female lizards were selected for scale counts (Table 1). It will be noted that the number of mid-body scale rows varied from fifty-seven to seventy-two. This variation of fifteen is slightly more than Loveridge experienced on counting mid-body rows in East African races. However, if female No. 10 is disregarded it will be seen that the variation is only eleven, which is well within the range for a race. It is quite probable that such variants as this occur in any race of lizards.

Coloration is variable and subject to change. Most of the descriptions which occur in the literature are based on preserved specimens and do not give an accurate picture of the lizard as it appears in life. The following is based on a freshly captured adult male. The head was dull orange with six ivory blotches on the margin of each upper jaw between snout and tympanum. The throat was also orange with ivory speckles which increased in number laterally and posteriorly. The dorsal surface of the lizard was dark blue, with the nape of the neck orange; an orange streak extends from the neck back along the mid-dorsal line about one-third of the distance between the fore and hind limbs. The ventral surface was blue-gray in color between the fore limbs and a lighter, more nearly ivory color posteriorly. The limbs were dull blue above and light beneath. The tail was mostly bluish in color with a distinct orange tinge half way between base and tip.

Habitat: Africana is the lizard most frequently encountered by man in the study area. This is due in part to the lizard's preference for more or less open areas. The lizard was often found on the college campus on the roofs of buildings, on the sides of buildings, along roadsides, on piles of brush, on solitary trees, and in fields which had been recently cut over.

*Submitted in partial fulfillment for the degree Master of Science, Miami University, 1954. Presented, in part, at the third annual meeting of The Ohio Herpetological Society, held at the Cleveland Museum of Natural History, June 19, 1960.

Away from the campus the lizard was found in similar situations. It was common on the sides and in the thatch of mud huts in native villages. It was sometimes encountered along trails between villages but usually in an area which was somewhat open. It was never encountered in deep rain forest. Attempts were made to secure specimens from transitional fields which were becoming secondary bush. Plots were laid out and systematic combing of the plots was done with the idea of checking population density but no lizards were found in several days of effort. As many as five lizards might be seen sunning themselves on the surface of the supports to the college water tanks. One of the preferences of the lizard is a vertical or near vertical slope on which to sun and run. Large trees, both standing and fallen, provide such surfaces in nature. Huts, bridges, and other man-made structures also serve this purpose. The lizard likes sunlight and during the hottest hours of the day may often be found in exposed positions.

Savage, in sending specimens to Hallowell, stated that the lizard is frequently encountered in native villages (Hallowell, 1845). In Nigeria, "they live in the roofs of houses, seem to be more frequent in villages and towns than in the actual bush" (S. F. Woodward, University College, Ibadan, Nigeria, in litt., April 29, 1953).

The writer tried to secure habitat data from native workmen who brought specimens. The bulk of the specimens received in this way were reported to be from rice "farms", which for the most part are newly cleared and burned low bush areas that are to be used for planting rice. Data from these sources were considered unreliable because of the language barrier between lizard captor and the investigator but it is certain that such areas do contain lizards. Romer (1953) reported that agamids were common in inhabited areas near Port Harcourt, Nigeria and that the lizards were quite tame and ate chocolate, pastry and biscuit from his hand. Cansdale (1951) noted that Gold Coast lizards slept gregariously in "roosts" under buildings with several dozen lizards together.

Growth and Development: Over two hundred lizards were captured and either marked and released or brought into the laboratory for study. Some of these results are recorded elsewhere (Daniel, 1954, 1960). It appears that the lizards approximately double their snout-to-anus length in the first year of life. Growth is slower in the second year of life and breeding adulthood is reached by both sexes at about 80 mm. snout to anus. Breeding adulthood may be reached in the second year.

From five to fourteen spherical follicles begin to enlarge in sexually mature females. These reach a maximum size of about 12 mm. Oviducal eggs in specimens numbered from three to nine and all were elliptical in shape and reached a length of 20.5 mm. Ovigerous and fecund females were present in all seasons of the year, indicating that breeding activity is not confined to a single season. An increase in the percentage of ovigerous individuals was found in the dry (November to March) and early rainy (April to June) season over the late rainy season (August to October). Eggs were found in loose lateritic soil in June but investigation of female lizards shows that egg laying probably takes place during the entire year with a possible peak in the early rainy season.

Most of the males over 80 mm. from snout to anus that were examined, contained motile sperm. Testes as small as 4 mm. and as large as 12 mm. contained motile sperm. Average testis length in adult male lizards was about 7 mm. An increase in testis size was noted in dry season males and early rainy season males over late rainy season males. This may indicate an increase in sperm production in the dry season and early rainy season.

Color patterns and color changes: This race shows brighter coloration among males. Males are characterized by bright orange and red markings contrasted with the more subdued shades of brown and gray on the necks, heads, and throats of the females. The juveniles resemble the adults except for a generally lighter appearance and the occurrence of yellow and green. A 52 mm. juvenile that was probably a female appeared in life as follows: The head was a brownish color flecked with green and yellow. There was a definite green and yellow line from the nostril to the ear which passed below the eye and above the upper labials. The back was brown with irregular black patches. There was a faint irregular orange streak along the lizard's sides. There were about twelve black blotches along the brown tail. The belly was white.

Color change is a well known phenomenon among lizards. Smith (1946) states that lizard coloration is due to chromatophores provided with pigment granules and oil droplets, to iridescent guaninin of the iridocytes of the dermis, and to the mechanical structure of the surface of the scales. Lizards that change color are dependent on pigment shifts in the melanophores. The amount of pigmentation is dependent on whether pigment granules are dispersed in the terminal branches of the melanophores that extend up into the leucophore layer of the dermis or whether the granules are found in the proximal portion of these branches.

The freshly captured male described earlier was observed further after being placed in a dark box for two hours at the prevailing Liberian temperature (26.5° C). The head, which had been a dull orange with ivory blotches along the upper jaw, was a uniform black with no apparent blotches. The throat remained orange but appeared duller. The

ivory blotches were still visible. The back was black instead of blue. The limbs and tail were a uniform gray instead of the bluish color. No orange was visible in the tail. The ventral surfaces were considerably lighter. The lizard was then handled and observed. The orange color began to reappear on the nape of the neck and the throat became a light orange. The lizard demonstrated an excited state by attempts to bite. The blue began reappearing on the dorsal surface beginning along the mid-dorsal line. After ten minutes the tail had an orange tint in its middle portion. The ventral surface of the lizard appeared darker. The lizard was then placed in a well lighted cage and after seven hours it appeared dark dorsally and was well camouflaged lying on the dark litter of the cage. Three other male lizards were observed under much the same conditions with very similar results.

These observations indicate that the race under consideration is quite adept at color change. Each lizard was placed in a dark container and after removal appeared dark in color with a minimum of orange. After handling in the light the blue and orange became apparent. After a quiet period in a well lighted container the lizards showed a darkening in color. It is quite probable that handling and excitement are at least partially responsible for the bright coloration in males of this lizard. This is not entirely responsible, however, for large quiescent males are often seen basking in the sunlight with bright reddish and orange heads. One of the vernacular names for the large male lizards is the "Red Headed Lizard".

Food Habits: The results of an analysis of the digestive tracts of ten freshly killed and preserved specimens (Table 2) indicate that ants, termites and adult beetles make up a large portion of the diet. The only non-insect food was a small arachnid of the order Chelonethida found in one stomach.

Enemies and Parasites: The literature provides very little on the predators of Agama agama africana. Hawks and owls were present in the study area and it is thought that at least some of these must include lizards in their diet. One rear-fanged snake, Boiga pulverulenta, was found with one lizard of this race in its stomach. Loveridge (1938) found two large agamid lizards in the stomach of the large, harmless Liberian file snake, Mehelya poensis. More intensive investigation will undoubtedly lengthen the list of snakes that include agamid lizards in their diet. Agamids were offered to a captive African Monitor Lizard, Varanus niloticus. A few were eaten but were generally refused.

The most obvious parasites found were red mites which infected at least half of the specimens brought into the laboratory. These were identified as Pterygosoma sp. of the family Pterygosomidae by Dr. R. W. Baker.

The Harvard Expedition of 1926-27 (Strong, 1930) collected plant and animal material from all parts of Liberia. It was routine procedure on this expedition to perform a necropsy and preserve parasite material encountered. Three nematodes were found in Agama agama africana. One of these (Oswaldocruzia agamae) was described as new by Sandground. This was found in the intestine. Another intestinal nematode found was Strongyluris brevicaudata. The tiny filarial worm Saussitus agamae Macfie was found in the vascular system. Several small flukes and a cestode which Sandground was not able to identify were also found.

Theiler (In Strong, 1930) studied blood films of this lizard and found two blood plasmodia. One was previously known, Plasmodium agamae Wenyon which was quite common in Gbanga lizards. It was sometimes found alone and sometimes with Plasmodium giganteum Theiler. The latter was a much larger organism with many more merozoites and was described as new by Theiler on the basis of films made on this expedition. The Strong report contains excellent illustrations of both species.

Summary: Agama agama africana (Hallowell) was investigated as to taxonomic significance, scutellation, coloration, growth, habitat, food habits, enemies and parasites. Over two hundred lizards were captured and either marked and released or brought into the laboratory for study. From these it appears that the lizards approximately double their snout-to-anus length in the first year of life. Growth is slower in the second year and breeding size is reached by both sexes at about 80 mm. Sexual maturity may be reached in the second year.

The lizard demonstrated several color phases. In general, male lizards that were handled and excited, demonstrated brighter coloration than quiescent individuals. Some sexual differences occur, with the large male possessing orange heads, and a zigzag orange stripe appearing on the sides of the adult females.

The race is found in the more or less open areas of its range and is quite common around villages. Its predators include snakes and lizards and undoubtedly other predatory animals. Red mites are ectoparasites and several nematodes and plasmodia act as internal parasites. The lizard feeds largely on insects. Ants, termites, beetles, grasshoppers, roaches and true bugs were found in the digestive tracts of preserved lizards.

I wish to thank the staff members, students, and laboring force of Cuttington College for aid in conducting the field phase of this investigation. I particularly want to express thanks to Mr. Sodienye Bendbow for assistance in making measurements and laboratory dissections. I also wish to thank Mr. Arthur Loveridge, formerly of the Museum of

TABLE 1

Scale counts from twenty selected Agama agama africana (Hallowell) from Suacoco, Liberia.

	Snout to Anus (mm)	Upper Labials Right	Upper Labials Left	Lower Labials Right	Lower Labials Left	Mid-body Scale Rows	Preanal Pores	Lamellae *
				Males				
1.	97	9	10	8	9	57	11	18
2.	75	10	10	9	10	68	14	18
3.	89	10	10	10	11	59	11	19
4.	100	10	9	9	8	67	10	18
5.	100	10	9	10	8	58	11	19
6.	83	9	9	9	9	61	12	16
7.	95	10	11	9	9	60	15	20
8.	83	8	10	10	8	59	11	18
9.	96	9	9	9	9	62	10	17
10.	84	10	8	10	9	65	12	18
Average		9.5	9.5	9.3	9.0	61.6	11.7	18.1
				Females				
1.	83	8	9	8	9	63	-	18
2.	86	9	8	10	9	58	-	18
3.	91	8	9	10	8	67	-	21
4.	87	9	9	8	7	63	-	17
5.	88	8	8	8	9	68	-	18
6.	58	9	9	8	10	62	-	16
7.	84	8	9	9	8	69	-	16
8.	82	9	9	9	8	65	-	17
9.	84	8	9	8	9	64	-	18
10.	90	9	9	9	8	72	-	19
Average		8.5	8.8	8.7	8.5	65.1	-	17.8

* Lamellae under fourth toe of left front foot.

TABLE 2

Analysis of stomach and intestinal contents of ten selected Agama agama africana.

	Ants	Termites	Beetles (Adult)	Beetles (Larva & pupa)	Grasshopper	Other Insects
Adult male	x	x	x	x		
Adult male	x					
Adult male	x	x				
Adult male	x		x		x	x
Adult male	x	x	x		x	
Subadult female			x			x
Adult female	x	x	x	x		x
Adult female	x	x	x			x
Adult female	x	x	x			
Adult female	x		x		x	

Comparative Zoology at Harvard University and now of St. Helena Island, South Atlantic, for making the original determinations of the race for me and for many helpful suggestions and Dr. Robert C. Stebbins, Museum of Vertebrate Zoology, University of California at Berkeley for criticism of the manuscript. I am deeply indebted to Drs. Robert Hefner, Robert Strecker, and Marion Boesel of Miami University for assistance and helpful criticism of the final phases of the study.

LITERATURE CITED

Boulenger, George Albert. 1885. "Catalogue of the lizards in the British Museum (Natural History), Vol. 1." 2nd ed., London: Brit. Mus. (N. H.), pp. xii + 1-436.

Cansdale, G. S. 1951. "Some Gold Coast lizards," Nigerian Field XVI (1): 21-34.

Daniel, Paul M. 1954. "A study of the West African lizard Agama agama africana (Hallowell)." Unpubl. Master's Thesis, Miami University, Oxford, Ohio.

----------. 1960. "Growth and cyclic behavior of the West African lizard, Agama agama africana," Copeia 1960 (2): 94-7.

Hallowell, Edward. 1845. "Description of new species of African reptiles," Proc. Acad. Nat. Sci. Phila., 1845, pp. 247-250.

Loveridge, Arthur. 1936. "African reptiles and amphibians in the Field Museum of Natural History," Field Mus. Nat. Hist., Zool. Ser. 22: 1-111.

----------. 1938. "On a collection of reptiles and amphibians from Liberia," Proc. New England Zool. Club 17: 49-74.

Romer, J. D. 1953. "Reptiles and amphibians collected in the Port Harcourt area of Nigeria," Copeia 1953 (2): 121-3.

Smith, Hobart M. 1946. "Handbook of lizards." Ithaca, N. Y.: Comstock, pp. xxii + 1-577.

Strong, Richard P. (Ed.). 1930. "The African republic of Liberia and the Belgian Congo." 2 vols. Cambridge, Mass.: Harvard Univ. Press., pp. 1-1064.